Use of Autumn Foliar Fertilization for Stimulating Early Dormancy: Potential Effects on Nitrogen Status, Vegetative Growth, and Fire Blight Susceptibility

Chuck Ingels, UC Cooperative Extension, Sacramento County
Jenny Broome, UC Cooperative Extension, Sacramento/Yolo/Solano Counties
Kitren Glozer, Plant Sciences Dept., UC Davis

Introduction

Rest-breaking treatments (fall defoliation and dormant oil applications) and PGRs applied for freeze mitigation and improved set may have effects on bloom and vegetative growth that could impact fire blight management. Vigorous shoots that are highly susceptible to blight strikes might be increased, decreased, or unaffected. Urea used in fall defoliation and for freeze mitigation may affect N management and vegetative vigor, thus impacting blight control. If added N due to urea use increases vigor, N management practices may need to change. This project is an addendum to the larger study, "Managing Bloom and Cropping in European Pear" (K. Glozer, P.I.), and its objective is to determine whether fall urea treatment affects fire blight susceptibility via changes in vegetative/reproductive growth.

Methods

In this trial, conducted in Sacramento County, a mixture of 1% copper (CuEDTA) + 2% urea was sprayed at 100 gpa with a commercial air-blast sprayer to defoliate trees before normal leaf fall. The trial was set up in a randomized complete block design, with four treatments and three replications. Treatment timings used were 1, 3, and 7 chill portions (11 October, 20 October, and 20 November, respectively), and untreated control. Sprays were applied to single tree rows.

To determine if fall urea applications affected leaf N concentration in the spring, leaves were sampled on 23 April and 11 June. At the April sampling, 4 shoot leaves and 4 non-bearing spur leaves were sampled from all 34 trees in each row. The June sampling also included 4 bearing spur leaves per tree. Samples were dried, ground, and analyzed for total nitrogen at the DANR Analytical Lab.

The orchard was walked several times to look for natural blight, however, none was found and the grower did not cut out any blight from this orchard. Therefore, we could not assess how the dormant season treatments affected natural blight incidence.

In late May we inoculated shoots to see if the susceptibility of shoots had been affected by the defoliation or dormant season treatments. On May 28, 2008, one healthy, young shoot on the northeast side of each of 10 trees in each replicate was inoculated with *Erwinia amylovora* (strain labeled Ea8) provided by Dr. Steve Lindow. We used a clean, sterile toothpick to scrape up a ball of bacteria (~1 mm) from the Petri plates. This toothpick was stabbed into marked shoots located at approximately 4-5 feet height, about 3 inches above the base of the shoot. Shoots were upright, vigorous, and at least 2 feet in length. Toothpicks with no bacteria on them were also stabbed into 5 healthy shoots. These shoots healed over and did not develop any visible lesions. Environmental conditions were not conducive to increase either natural or inoculated blight, although the grower was irrigating on the day we inoculated, which provided some humidity for bacterial colonization within the tissue.

Marked shoots were completely removed and placed in a plastic bucket containing water on 11 June 2008 and taken back to the lab. Blackened fire blight lesions were observed on these shoots, however lesion growth was very limited. Lesion length was measured on 11 June 2008. We stored the shoots overnight in water with plastic bags over them and measured the lesion length again 24 hours later after storage at 4 C. Some lesions elongated with the overnight storage, others did not, so variation in lesion length was also higher.

As a measure of tree vigor, 4 trees from each treatment replicate were pruned in early Dec. 2008 and the prunings weighed. Trees selected were full canopied, with normal scaffold development and no major limbs removed from blight damage.

A telephone survey of growers was conducted in 2008 for purposes of establishing baseline N fertilization practices of Bartlett pears and any reported grower experience on N fertilization programs and fire blight interactions.

Leaf tissue nitrogen levels and pruning weights were analyzed using Statgraphics software program. Fire blight lesion length data were analyzed using SAS 9.1 GLM for treatment effects and mean separation using the Waller Duncan K ratio T test at $P = 0.05$.

Results and Discussion

Leaf Nitrogen Analyses. Leaf nitrogen status of shoot leaves in the defoliation trial was reduced in April by defoliation at 1 and 3 CP (Table 1). A similar trend was found in non-bearing spur leaves in April and June. It may be that early defoliation, whether by urea or not, disrupts the ‘normal’ storage of nitrogen in early fall. By the time the 7 CP application was made (20 November), much of the N had apparently already translocated back into the woody tissues. Nonetheless, all values showed nitrogen levels in excess of the critical threshold level recommended N for pear of 2.2% (Pear Production and Handling Manual, UC ANR Publ. 3483, 2007). This may be a concern for excessive vegetative vigor.

Fire blight. A conclusive relationship between dormant season defoliation treatments with urea and how this might affect orchard fire blight incidence cannot yet be determined due to a lack of conducive weather this year and, possibly, due to high background nitrogen tissue levels. When we performed an artificial shoot inoculation with the fire blight pathogen in late May 2008, treatment effects for lesion length on shoots assessed right after removal from the orchard was not quite significant $P = 0.06$., although slightly longer lesions did appear to develop for the defoliation at 1 chill portion (CP) treatment (Table 2) relative to the control or other treatments. However, leaf N status for this treatment (1 CP) and also 3 CP was actually lower than that of other treatments, even though increased fire blight susceptibility has been reported for higher N status tissues. One overarching problem may be that N levels were excessive in all tissues tested with the possible exception of fruiting spurs in June, and this would swamp any treatment effects related to tissue N status and susceptibility to fire blight.

Pruning Weights. There were no differences in pruning weights (Table 3). Leaf N levels were more than adequate, so any differences in leaf N were unlikely to affect vigor.

Grower Survey. A total of 11 growers were surveyed about their general N fertilization practices, representing 4,300 acres of Bartlett pears (Table 4). Three growers apply 60 lbs./acre/year or less, six growers apply 100 to 160 lbs., and two growers apply 175 to 200 lbs. The average rate used by all growers surveyed is 118 to 125 lbs./acre, and on an acreage basis the average is 124-131 lbs./acre. All but one grower uses split applications, and the grower applying all the N at one time uses the highest rate. Seven of the growers include a postharvest application (most in early fall), and several growers used about half to two-thirds of the total N in the fall. The most widely used fertilizer is calcium nitrate, which is used at least in part by seven growers. The method of application is split fairly evenly between broadcast and fertigation.

All growers interviewed sample leaves for nutrient analyses – most on an annual basis, but two growers sampled every 2+ years and one grower sampled multiple times per year (data not shown). Three growers also sample soils each year for analyses. Most growers stated that they based N fertilization rate decisions in part on leaf analysis, either their own evaluation or that of the lab report. Six of the growers said they also based the rate on crop load (lower rate if light, higher rate if heavy) and/or tree vigor (lower rate if vigorous, higher rate if weak). If fruit set is light, some growers will forego a late spring or early summer application to prevent excessive growth and/or to reduce expenses. Most growers generally see no obvious relationships in N rate vs. high vigor or N rate vs. fire blight, but about half have seen a relationship between high vigor and blight.

Table 1. Effects of chemical defoliation in 2007 (10 lb urea + 10 lb copper chelate per acre) on leaf nitrogen (N) status in 2008. First pick on 11 April; second pick on 11 June.

Treatment[x]	**Collection timing**	
	April	**June**
Shoot leaf		
Untreated	3.00 a [y]	2.83 a
1 CP Oct 11	2.83 b	2.69 a
3 CP Oct 20	2.84 b	2.71 a
7 CP Nov 20	2.98 a	2.75 a
Non-bearing spur leaf		
Untreated	2.89 a	2.77 ab
1 CP Oct 11	2.66 b	2.64 b
3 CP Oct 20	2.76 ab	2.68 ab
7 CP Nov 20	2.95 a	2.79 a
Fruit-bearing spur leaf		
Untreated	--	2.52 a
1 CP Oct 11	--	2.33 a
3 CP Oct 20	--	2.34 a
7 CP Nov 20	--	2.47 a
Comparing treatment only, leaf types combined		
Untreated	2.94 a	2.71 a
1 CP Oct 11	2.74 b	2.55 a
3 CP Oct 20	2.80 b	2.58 a
7 CP Nov 20	2.96 a	2.67a

[x] Defoliant application timing by chill portion (CP) accumulation and date.
[y] Mean separation within columns and leaf types by Duncan's Multiple Range Test, $P = 0.05$.

Table 2. Mean fire blight lesion length on inoculated shoots (inoculated May 28, 2008) in defoliation trial Bartlett pear orchard 2007-2008 season.

Treatment	June 11 (inoculated shoots assessed in orchard)[x]	June 12 (inoculated shoots assessed after 24 hr incubation) [y]
Untreated control	1.56 a	2.72 a
Urea at 1 CP	2.84 b	4.48 a
Urea at 3 CP	1.64 a	1.96 a
Urea at 7 CP	1.70 a	2.29 a

[x] Lesion length on shoots assessed right after removal from the orchard was not quite significantly different for any treatment P = 0.06. Means in the same column with the same letter are not significantly different according to the Waller Duncan K ratio T test for mean separation at P = 0.05.

[y] Lesion length after 24 hours incubation in moist, cold temperatures on 6/12/2008 was not significantly different for any treatment (P=0.20).

Table 3. Weight of branches pruned from selected trees in each treatment row (n=4 per replicate, 12 per treatment).

Treatment	Mean Pruning Weight (lbs./tree)
Untreated control	62.1 a
Urea at 1 CP	66.0 a
Urea at 3 CP	54.6 a
Urea at 7 CP	53.9 a

[1] Treatment means not significantly different (Tukey HSD test, P = 0.15).

Table 4. Bartlett pear nitrogen fertilization practices of 11 Sacramento County growers (total of 4,300 acres).

Grower	Fertilization Frequency	Fertilization Timing	Fertilizer Products	Quantity (lbs./acre) Per Timing	Total/Yr.	Qty. Based in Part On:	Fertilization Method
1	2x/yr.	May, June	CAN-17	30 each	60		Injection
2	2x/mo.	Thru harvest	CaNO3		60	Vigor	Injection
3	1x	PH[1]	KNO3	100	175	Vigor, Crop Load	Broadcast
	3x	Spring	CaNO3	25 each			Broadcast
	2x/mo.	Irrig.	CAN-17		175		Injection
4	1x/yr.	PH	NH4NO3	100	150	Crop load	Broadcast
	2x/yr.	Spring	CaNO3	25 each			
5	3x	Apr, June, PH	CaNO3 or CAN-17		120-140		Broadcast
							Injection
6	2x/yr.	June, PH	UN-32	20 each	40	Vigor	Injection
7	2x/yr.	Apr, June	NH4NO3	30 each	120	Crop load, Vigor	Broadcast
	1x/yr.	PH	NH4NO3	60			Broadcast
8	3-4x/yr.	Apr, May, June	UN-32	100	150		Injection
			UN-32	50			Injection
9	1x/yr.	June	CaNO3		200		Broadcast
10	3x/yr.	Apr, May, June	CaNO3		120		Broadcast
	1x/yr.	PH	CaNO3	20			Broadcast
11	1x/yr.	Spring	CaNO3	40-100	100-160	Crop load	Broadcast
	1x/yr.	PH	Urea	60			Broadcast
Average N Rate (by Grower)					118-125		
Average N Rate (by Acreage)					124-131		

[1]PH = Postharvest